ENGINEERING

CITY OF DUBLIN.

Stormwater Management Design Manual

February 2007

THIS PAGE INTENTIONALLY
LEFT BLANK

Table of Contents

THIS PAGE INTENTIONALLY
LEFT BLANK

Introduction

Purpose

The purpose of this manual is to provide City standards and maintain uniformity in design standards for stormwater management. This also allows the City to provide effective and efficient review of design data.

Stormwater management is an evolving science. The goal of the City is to be responsive to updating its standards to reflect the most innovative, creative and cost-effective practices available. To achieve this goal, this manual will be revised and updated as necessary to reflect accepted new standard practice s in the area of stormwater management.

This manual rescinds the Division of Engineering Administrative Policy 98-028.

Applicability

This manual applies to all projects in the City. This includes the alteration, construction, installation, demolition or removal of a structure, impervious surface or drainage facility; or clearing, scraping, grubbing, killing or otherwise removing the vegetation from a site; or adding, removing, exposing, excavating, leveling, grading, digging, burrowing, dumping, piling, dredging or otherwise significantly disturbing the soil, mud, sand or rock of a site.

DESIGN CRITERIA

A. Hydraulic Design Criteria

1. The City's Stormwater Master Plan shall be used to provide design flows and detention requirements for major drainage systems within the City.

2. For on-site drainage systems, hydrograph routing methods shall be used to design stormwater detention facilities and either hydrograph routing or peak flow methodologies may be used to design stormwater conveyance facilities.

3. Hydraulic Design Criteria: Rainfall intensities are to be obtained from the "Rainfall Frequency Atlas of the Midwest", 1992. Rainfall intensity-duration-frequency curves, which were developed from this Atlas and which can be used to determine rainfall intensities.

B. Detention/Retention Facilities

A detention/retention facility shall be installed on all development projects, unless the applicant demonstrates that the project will not increase the peak rate of runoff; volume, or frequency of the runoff hydrograph of the site prior to development. Detention/retention facilities shall be designed in the following manner:

1. *Studied areas*. Parcels located within drainage sub-basins established in the Stormwater Master Plan, or any subsequent update thereto shall comply with the runoff release rate for each frequency storm specified in the Stormwater Master Plan.

    a. Critical storm controls. Determine the total volume of runoff from a 1-year, 24-hour storm, occurring over each of the site's drainage areas before and after development.

b. Determine the percent of increase in runoff volume due to development and using this percentage, select the critical storm from the table:

CRITICAL STORM DETERMINATION		
If the Percent of Increase in Runoff Volume is		**The Critical Storm Runoff Rate Will Be Limited to:**
Equal to or Greater than	**And less than**	
--	10	1 year
10	20	2 year
20	50	5 year
50	100	10 year
100	250	25 year
250	500	50 year
500	--	100 year

c. The peak rate of runoff from the critical storm occurring over the developed site shall not exceed the peak rate of runoff from a 1-year, 24-hour storm occurring over the same area prior to development, as defined in the Stormwater Master Plan. Storms of less frequent occurrence (longer return period) than the critical storm, shall have the peak rate of runoff not greater than for the same storm under pre-development conditions.

2. *Unstudied areas*. Detention/retention facilities designed for parcels located outside drainage sub-basins established with the Stormwater Master Plan, or any subsequent update thereto shall comply to the following minimum design criteria:

a. Development of sites other than single-family and less than or equal to 2.0 acres shall not release stormwater runoff greater than 0.2 cubic feet per second per acre of development. On-site detention storage shall be provided to achieve these peak flow rates.

b. Development sites greater than 2.0 acres (including single-family lots) shall provide runoff controls as defined by the MORPC Stormwater Design Manual.

3. Stormwater detention and retention ponds which are considered by Ohio Department of Natural Resources (ODNR) to be dam structures regulated under the dam safety laws of the State of Ohio shall be designed to safely pass the design flood events as defined by ODNR. Where fill berms are proposed, calculations supporting the stability of the fill berms are to be submitted by a licensed professional engineer with demonstrated experience in geotechnical engineering. The applicant shall design all raised bermed stormwater ponds according to current ODNR dam safety criteria.

4. If the site has multiple drainage basins, the drainage basin divides that exist prior to development shall be used to determine predevelopment rates of discharge for each drainage area of the site.

5. Fenced stormwater facilities are strongly discouraged within the city and shall only be permitted if approved by the city. The city will consider fencing stormwater facilities only where steep slopes which potentially endanger human life are unavoidable. If fencing is required, the design shall conform to the City's fence code (Chapter 153 of the Zoning Code) along the right-of-way boundary around the entire perimeter, including maintenance berms with access for maintenance vehicles. Other designs may be permitted subject to the review and approval of the City Engineer.

6. Areas adjacent to stormwater detention and retention basins and ponds shall be graded to restrict the entrance of stormwater except at planned locations. Where retention/detention basins are located on the project periphery, the developer may be required to provide additional landscaping or screening to adequately protect abutting properties.

7. The minimum requirement for maintenance berms is as follows:

PONDS	MINIMUM MAINTENANCE ACCESSWAY REQUIRED
With perimeter fencing	20 feet around perimeter
Without perimeter fencing	15 feet around perimeter
Access easement	20 feet along a designated corridor between the pond and a public right-of-way (lesser accessways are subject to the approval of the City Engineer)

8. Detention/retention basins shall also be designed to meet the stormwater runoff quality requirements of Section F.

9. Headwalls shall be required at all storm sewer inlets or outlets to and from stormwater management facilities. Stone and/or brick approved by the City Engineer shall be provided on all visible headwalls.

C. Storm Sewers

1. Public storm sewers shall be designed such that they do not surcharge from runoff caused by the 5-year, 24-hour storm, and that the hydraulic grade line of the storm sewer stays below the gutter flow line of the overlying roadway, or below the top of drainage structures outside the roadway during a 10-year, 24-hour storm.

2. Private storm sewers shall be designed such that they do not surcharge from runoff caused by the 2-year, 24-hour storm, and that the hydraulic grade line of the storm sewer stays below the gutter flow line of the overlying roadway, or below the top of drainage structures outside the roadway during a 5-year, 24-hour storm. The system shall be designed to meet these requirements when conveying the flows from the contributory area within the proposed development and existing flows from offsite areas that are upstream from the development**.**

3. Stormwater runoff from offsite areas that discharge to or across a development site shall be conveyed through the stormwater facilities planned for the development site at their existing peak flow rates during each design storm. No stormwater management plans will be approved until it is demonstrated that offsite runoff will be adequately conveyed through the development site in a manner that will not exacerbate upstream or downstream flooding and erosion.

4. The minimum inside diameter of pipe to be used in public storm sewer systems is 12 inches. Smaller pipe sizes may be used in private systems, subject to the approval of the City Engineer.

5. All storm sewers shall be designed and constructed to produce a minimum velocity of 3.0 feet per second (fps) when flowing full. The City Engineer may impose additional hydraulic design criteria for any storm sewer system or portion thereof designed at a supercritical slope and/or with a full-flow velocity in excess of 10 fps.

6. The outlet ends of all storm sewers shall be provided with sufficient energy dissipaters and erosion protection. See Standard Drawings for details.

7. The following maximum lengths of pipe shall be used when spacing access structures of any type:

PIPE SIZE	STRUCTURE SPACING
12 to 18 inches	300 feet
24 to 36 inches	400 feet
42 inches and larger	500 feet

8. All storm sewer systems shall be designed taking into consideration the tailwater of the receiving facility or waterbody. The tailwater elevation used shall be based on the design storm frequency.

9. The hydraulic grade line for the storm sewer system shall be computed with consideration for the design tailwater on the system defined in the Stormwater Master Plan and the energy losses associated with entrance into and exit from the system, friction through the system, and turbulence in the individual manholes, catch basins, and junctions within the system.

10. The minimum cover for storm sewers within the right-of-way shall be one foot measured from the top outside of pipe to the bottom of underdrain at the back of curb. Should underdrains not be required, the minimum cover shall be one foot measured from the top outside of pipe to the top of subgrade at the back of curb. Outside street right-of-way, a minimum two feet of cover shall be provided measured from the top of finished ground surface to the top outside of pipe.

11. All storm sewers shall be backfilled with Item 912 within the right-of-way and the area of influence of pedestrian paths, fire apparatus access roads, and maintenance berms. All others area shall be backfilled with Item 911.

12. The desired maximum distance for overland flow should be 300 feet before entering a storm structure.

13. The desired maximum overland drainage area tributary to the storm structure should be no greater than 1.5 acres.

14. The maximum spacing of curb inlets shall not exceed 300 feet, or that spacing which shall permit a maximum permissible spread. Spread calculations shall be provided with all storm drainage calculations. Maximum permissible spread is 6' from edge of pavement for streets less than 28 feet measured back to back of curb. A 12-foot clear lane shall be maintained for streets wider than 28 feet. A design storm of 5-years shall be used for determine allowable spread.

15. Within a residential subdivision, catch basins shall be installed in the rear lots approximately every third lot. The property shall be graded in such a way to provide that the stormwater can reach the catch basin through a swale or another measure as approved by the City Engineer.

16. The inverts of all curb and gutter inlets, manholes, catch basins, and other structures shall be formed and channelized.

17. Storm sewer structures shall have grates that permit safe crossing by bicycles as approved by the City Engineer.

18. In areas where public safety concerns (specifically with children) and welfare are an issue, the City Engineer may require that any storm sewer outlet greater than 18 inches in diameter accessible from stormwater management facilities or watercourses shall be provided with safety grates, as approved by the City Engineer.

19. Headwalls shall be required at all storm sewer inlets or outlets to and from open channels or lakes. Stone and/or brick approved by the City Engineer shall be provided on all visible headwalls.

D. Culverts and Bridges

1. Roadway stream crossings other than bridges shall be designed to convey the stream's flow for the 25-year, 24-hour storm, with a maximum headwater depth that does not cause flooding or significantly pressurize the culvert, as defined by the Ohio Department of Transportation.

2. The minimum inside diameter of pipes to be used for culvert installations under roadways shall be 12 inches. The minimum inside diameter of pipes to be used for driveway crossings shall be 12 inches.

3. The maximum slope allowable shall be a slope that produces a 10-fps velocity within the culvert barrel. Erosion protection and/or energy dissipaters shall be required to properly control entrance and outlet velocities.

4. All culvert installations shall be designed with consideration for the tailwater of the receiving facility or waterbody. The recurrence frequency of the tailwater elevation shall be the same as the culvert design storm frequency.

5. The determination of the required size of a culvert installation can be accomplished by mathematical analysis or by the use of design nomographs.

6. Headwalls shall be required at all culvert inlets or outlets to and from open channels or lakes. Stone approved by the City Engineer shall be provided on all visible headwalls.

7. The minimum cover for culverts within the right-of-way shall be one foot measured from the top outside of pipe to the bottom of underdrain at the back of curb. Should underdrains not be required, the minimum cover shall be one foot measured from the top outside of pipe to the top of subgrade at the back of curb. Outside street right-of-way, a minimum two feet of cover shall be provided measured from the top of finished ground surface to the top outside of pipe. The structural design of culverts and bridges shall be the same as that required by the Ohio Department of Transportation.

8. Bridges shall be designed such that the hydraulic profile through a bridge shall be below the bottom chord of the bridge for either the 100-year, 24-hour storm, or the peak 100-year flood elevation, whichever is more restrictive.

9. 100-year HGL: Demonstrate that the hydraulic grade line resulting from the 100-year, 24-hour storm does not encroach on the roadway above the culvert or above

the low chord of bridge. The HGL shall be shown graphically on the storm sewer construction plans or on a tabulation spreadsheet.

10. Velocities: Tabulate the culvert flow velocities, and demonstrate that the velocities do not exceed 10 feet per second within the culvert barrel.

11. Tailwater and energy loss: List all tailwater assumptions and their source for applicable design storm events. List the energy loss assumptions at the entrance/exit of the structure.

E. Open Channels

1. Where applicable, streams within the City shall be preserved and protected according to criteria in Section 53.200. Requirements for increasing the conveyance capacity, repairing streambank erosion damage, restoring floodplain storage, and/or rehabilitating aquatic or riparian habitat shall be determined by the City Engineer based on the Stormwater Master Plan or other site-specific criteria necessary to protect the public health, safety and welfare or satisfy pertinent state and federal regulatory requirements.

2. Wherever possible, drainage tributary to streams, wetlands, lakes, and detention facilities shall be maintained by an open channel with landscaped banks designed to carry the 10-year, 24-hour stormwater runoff from upstream contributory areas. The City Engineer may increase the design storm as conditions require.

3. Alterations to streams and other open channels within FEMA floodplains shall be designed according to the requirements of Chapter 151 of the Dublin Code of Ordinances along with the requirements contained with this chapter. All open channels shall be designed with one foot of freeboard above the design water surface elevation of the open channel flowing full.

4. Flood relief channels shall be designed to convey the runoff from the 100-year, 24-hour storm, such that a positive discharge of this runoff to an adequate receiving stream or conveyance system results without allowing this runoff to encroach into proposed or existing residential dwellings or places of business.

5. Roadside ditches along existing roadways may be required by the city to be enclosed if ODOT standards for safety and maintenance cannot be satisfied.

6. Capacity: Demonstrate that the hydraulic grade line resulting from the 10-year, 24-hour storm does not rise to within one foot of the top of bank.

7. 100-year HGL: Demonstrate that the water elevation resulting from the 100-year, 24-hour storm does not encroach into proposed or existing residential dwellings

or places of business. The flood elevation shall be shown on the Stormwater Management Map for the project.

F. Stormwater Runoff Quality

1. No person shall:
    a. Construct, maintain, operate, and/or utilize any illicit connection.
    b. Cause, allow or facilitate any prohibited discharge.
    c. Act, cause, permit, or suffer any agent, employee, or independent contractor to construct, maintain, operate or utilize any illicit connection, or cause, allow or facilitate any prohibited discharge.

2. Outdoor activity areas within the development site shall be delineated on the Stormwater Management Plan, and the activities that will be conducted within them shall be described in the Plan.

3. Runoff from outdoor activity areas shall not be allowed to co-mingle with runoff from the remainder of the site, and shall be directed to separate treatment systems, as approved by the City Engineer.

4. The site shall be designed to direct runoff from areas other than outdoor activity areas to one or more of the following stormwater quality treatment best management practices (BMPs):

    a. Swales;
    b. Filter strips;
    c. Wet detention basins;
    d. Extended dry detention basins;
    e. Media filters; or
    f. Other approved BMPs.

5. The design water quality volume for these BMPs shall be the runoff from the first three-quarter inch of rainfall of each and every storm event. Runoff calculations in this section shall use runoff quality coefficients appropriate for storm events of less than 1 inch of precipitation under average antecedent moisture conditions.

6. In addition, BMPs shall be designed to accommodate flows exceeding their design capacity, either by bypassing excess flows, conveying excess flows through the facility without disrupting its stormwater quality control effectiveness, or storing excess flows as necessary to achieve the drainage, flood control, and erosion control objectives of this chapter.

7. Filter Strips and Swales

a. Drainage areas of all swales and filter strips shall not exceed five acres or possess slopes greater than 2.0 percent. They shall be designed to convey a hydrograph with the following characteristics:

   V_h = A*r*P (acre-feet), where:

   1. V_h = hydrograph volume, acre-feet
   2. A = area tributary to the basin, acres
   3. r = runoff quality coefficient (Refer to OEPA for values)
   4. P = mean storm precipitation volume = 0.0625 feet
   5. Hydrograph duration = 2 hours

b. Hydrograph peak shall be calculated according to the Rational Formula methodology.

c. Maximum depth of flow shall be no greater than three inches.

d. Swales and filter strips shall be lined with fine, turf-forming, water-resistant grasses to slow and filter flows.

e. Show the calculation of hydrograph volume (Vh) as described in the Ordinance.

f. Hydrograph intensity: Show the calculation converting the hydrograph volume to intensity (in inches per hour) over two hours. This calculation can be made by multiplying the hydrograph volume (in acre-feet) by 6, then dividing this quantity by the area (in acres) tributary to the swale.

g. Intensity-duration-frequency curve: Show the intensity-duration-frequency curve that is used to determine the intensity corresponding to the time of concentration. This is accomplished by drawing a curve parallel to the *"Rainfall Frequency Atlas of the Midwest"* intensity-duration-frequency curves that contains the point with 2-hour duration and the intensity calculated in Step b above.

h. Design flow rate: Show the calculation of the swale/filter strip design flow rate using the Rational Formula. The intensity used in the calculation is obtained from the curve drawn in Step c above, at duration equal to the time of concentration for the tributary area.

i. Geometry: Show the calculation of the swale/filter strip cross-section geometry using the Manning Equation. Demonstrate that the flow depth is no greater than three inches for the design storm calculated above.

8. Retention basins and stormwater wetlands

a. Shall consist of a permanent pool volume (V_b) that does not drain between storm events, plus an extended detention volume of approximately equal size above the permanent pool, plus a sediment storage volume at least 20 percent of the volume of the permanent pool. The permanent pool and extended detention volumes shall each be sized according to the following equation:

   $V_b = 0.75A*r*P$ (acre-feet), where:

   1. V_b = permanent pool **or** extended detention volumes, acre-feet
   2. A = area tributary to the basin, acres
   3. r = runoff quality coefficient = (Refer to OEPA for values)
   4. P = storm precipitation depth = 0.0625 feet

b. Therefore, the total volume of the facility = $V_b + V_b + 0.2V_b = 2.2V_b$

c. The outlet shall be designed to release the entire extended detention volume in no less than 24 hours. A method shall also be provided to drain the permanent pool volume to facilitate the removal of accumulated sediments and other maintenance activities. The outlet shall also be designed to minimize clogging, vandalism, and maintenance.

d. The basin design shall incorporate the following features to maximize multiple uses, aesthetics, safety, maintainability, and compatibility with the urban landscape:

   1. Basin side slopes above the permanent pool shall have a run to rise ratio of 4:1 or flatter. One foot of freeboard shall be provided.

   2. To promote growth of wetland vegetation over 25 to 50 percent of the pond surface area, an aquatic bench, with 10:1 side slopes, shall be provided, with a maximum depth of 18 inches below the proposed normal pool water surface elevation and a minimum of five feet wide. The aquatic bench shall be planted with hearty plants comparable to wetland vegetation which are able to withstand prolonged inundation.

   3. Basin depths in open water areas shall not exceed 12 feet to prevent thermal stratification.

   4. A forebay or other sediment removal devices designed to allow larger sediment particles to settle shall be placed at basin inlets. The forebay volume shall be equal to approximately 10% of the

extended detention volume (V_b). Hard-bottomed forebays shall be required for those facilities maintained by the City. Alternative bottoms for all other forebay facilities maintained non-municipal parties shall be approved by the City Engineer and contingent upon providing details of a maintenance plan which addresses related potential access issues.

5. A stable vehicular access way shall be provided to forebays and outlets.

e. The wet ponds or wetland shall be designed and maintained in a manner that maintains to improve water quality (oxygen levels) such that unwanted vegetation, stagnation and mosquito colonies are prevented and the water quality remains habitable for aquatic species. The City Engineer shall develop and enforce design and maintenance criteria that achieve this objective which may include but is not limited to aquatic habitat design features, vegetation control measures and mechanical aerators.

f. Stormwater wetlands may be used in place of the permanent pool if designed and constructed according to recognized wetland design principles. The wetland shall have a water volume equal to the required volume for the permanent pool, and shall consist of depressed, heavily planted areas designed to maintain flow during dry periods in order to support aquatic vegetation. The amount of surface area required for a stormwater wetland is typically larger than that of a wet pond due to the limited allowable depths required for wetland design.

9. Extended dry detention basins

a. Shall consist of an extended detention volume and a sediment storage volume at least 20 percent of the volume of the permanent pool. The extended detention volume shall be sized according to the following equation:

$V_b = A*r*P$, where:

1. V_b = extended detention volumes, acre-feet
2. A = area tributary to the basin, acres
3. r = runoff quality coefficient (Refer to OEPA for values)
4. P = storm precipitation volume = 0.0625 feet

b. Therefore, the total volume of the facility = $V_b + 0.2V_b = 1.2V_b$

c. The sediment storage volume shall be no less than 20 percent of the extended detention volume. The outlet shall be designed to release 50 percent of the extended detention volume in no less than 16 hours, and the

remainder of the extended detention volume in no less than 32 hours (for a total of 48 hours).

d. The outlet shall also be designed to minimize clogging, vandalism, and maintenance. The basin design shall incorporate the following features to maximize multiple uses, aesthetics, safety, maintainability, and compatibility with the urban landscape:

e. Basin side slopes shall have a run to rise ratio of 4:1 or flatter and vegetated to prevent bank erosion and minimize drowning risk. Bottom channels shall be graded shall be such that it drains within 72 hours to prevent standing water. One foot of freeboard shall be required.

f. A forebay or other sediment removal device designed to allow larger sediment particles to settle shall be placed at basin inlets. The forebay shall be equal to approximately 10% of the extended detention volume (V_b).

g. A stable vehicular access way shall be provided to forebays and outlets.

10. Media filters

a. Shall consist of a settling basin followed by a filter basin filled with sand, peat, or amended soil or other media with a diameter between 0.02 and 0.04 inches, as approved by the City Engineer. The settling basin shall have a settling volume calculated using the following:

$V_b = A*r*P$, where:

1. V_b = settling volume, acre-feet
2. A = area tributary to the basin, acres
3. r = runoff quality coefficient (Refer to OEPA for values)
4. P = storm precipitation volume = 0.0625 feet = 0.75 inch

b. The settling basin shall also include a sediment storage volume no less than 20 percent of the settling volume. The settling basin shall also have a length to width ratio of at least 2 to 1, and a depth between 3 feet and 10 feet. The outlet of the settling basin shall be sized to release the entire settling volume within 40 hours (extended drawdown time). The filter basin shall be designed with a surface area of 600 square feet per tributary impervious acre, a filter depth of 1.5 feet, and a maximum water depth above the filter surface of 6 feet.

11. *Other BMPs* may be recommended to satisfy the requirements of this chapter if the stormwater management plan for the site demonstrates to the satisfaction of the City Engineer that these BMPs achieve effluent quality and runoff volume

reduction equivalent to approved. BMPs can be adequately maintained and satisfy other sections of the stormwater regulations.

12. *Mosquito Control Considerations*. Growth of aquatic vegetation shall be restricted to the periphery of detention ponds. The presence of a mechanical aerator, such as a fountain in the middle of the pond, may be used to make the site more attractive, deter the growth of unwanted vegetation, and make the habitat more suitable for fish. In general, grading of stormwater drainage structures shall be such that water is not retained for longer than 72 hours.

G. Floodplain Encroachment Calculations

Shall be presented in the following format:

1. 100-year HGL: Demonstrate that development in a FEMA Special Flood Hazard Area (SFHA) flood plain does not increase the 100-year flood elevations. Show calculations or computer model output that demonstrates the pre-development and post-development flood elevations. Developer should include an SFHA permit and the appropriate fee with the Stormwater Management Plan.

2. Compensating storage: Demonstrate that any volume of fill placed in the 100-year floodplain is compensated with an equal volume of material removed above the ordinary high water table and below the 100-year flood elevation. Show the volume calculation for the fill and the compensating storage.

Note: Please refer to Chapter 151, City of Dublin Codified Ordinances for further information regarding floodplains and floodways.

H. Sinkholes

1. Construction in Sinkhole Drainage Areas: The immediate area around a sinkhole should be disturbed as little as possible. The use of mechanized equipment near the sinkhole should be avoided. Sink areas are known to be unstable for construction. Structures placed on soil foundations in sink areas may be subject to both settling and collapse of the sink. Uncontrolled fill placement may present additional settlement hazards. It shall be required that appropriate geotechnical studies be done and measures taken to insure structure foundations are designed to take into account potential sinkhole locations and instability. Such studies shall account for potential foundation problems for both undisturbed sink areas and those previously filled by others.

2. The floodplain line for a sinkhole is defined by the sinkhole lip elevation. Therefore, the storage volume beneath this elevation is the sinkhole floodplain storage volume. *The pre-development floodplain storage volume must be preserved under post development conditions*. If any fill is added in the floodplain

outside the no-fill lines, compensating excavation in the floodplain shall be required.

3. The no-fill line shall be established by the contour line or interpolated contour line for the elevation that defines 60% of the floodplain storage volume. The area encompassed by this line shall be defined as a no-fill zone for all construction activities. No construction fill will be allowed in this zone.

I. Stormwater Management Plan

1. *General Requirements*.

   a. A stormwater management plan shall be prepared by the applicant for each proposed development activity and approved by the City Engineer in accordance with Section 53.120 if the plan demonstrates that the proposed development activity has been planned and designed, and shall be implemented and maintained to meet the performance criteria described herein.

   b. This stormwater plan shall be part of the overall submitted improvement plan and not a separate submittal. Supporting calculations for each design storm specified in § 53.090 hereof shall be submitted (hard copy and original copy) and will contain, as a minimum, a runoff hydrograph for the undeveloped and developed site, stage-storage calculations for the detention facility, stage-discharge calculations for the outlet structure, and a runoff hydrograph after routing through the proposed detention facility. All routing calculations shall account for tailwater conditions of the receiving facility, and shall be submitted to the city.

   c. The Stormwater Management Plan shall be a bound report containing all pertinent stormwater calculations for detention/retention basins, storm sewers, culverts, open channels, and other stormwater management system features, including best management practices (BMPs) specified in the Stormwater Ordinance. The Stormwater Management Map shall be included in a sleeve page or pocket of the report. The construction plans shall be submitted with the report, but not attached to it. The report shall contain divider pages with labeled tabs that clearly identify the calculations contained in each section.

2. *Map Content*.

a. The project engineer shall include in the construction plans a master stormwater management map showing all existing and proposed features, including trees. The map is to be prepared on a 24-inch by 34-inch sheet on a scale not to exceed 1" = 400'. Listed below are the features that are to be included on the map.

1. Based on state plane coordinate system.
2. Existing and proposed contours at one-foot intervals.
3. North arrow and scale.
4. Pre-development and post-development subbasins overlaid on the same map including on and offsite contriburary area. The acreages shall be shown.
5. Downstream receiving waterway of drainage system.
6. Pre-development and post-development overland flow paths to and from the management basins.
7. Soil type by subbasin including hydrologic soil group designation of A, B, C or D.
8. Hydrologic boundaries, including all areas flowing to the proposed project.
9. Project boundaries and area.
10. Sufficient topographical information with elevations to verify the location of all ridges, streams, etc. (one-foot contour intervals within the project's boundaries and for proposed offsite improvements).
11. High water data or critical flood elevations on existing structures upstream of, within, and downstream of the project.
12. Notes indicating sources of high water data and critical flood elevations.
13. Notes pertaining to existing standing water, areas of heavy seepage, springs, wetlands, streams, and hydrologically sensitive areas.
14. Existing stormwater management features (ditches, pipes, roadways, ponds, and BMPs). Existing stormwater management features are to be shown a minimum of 1,000 feet downstream of the proposed development unless the ultimate outfall system is a lesser distance.
15. Subdivision layouts with horizontal and vertical controls.
16. Proposed and existing stormwater management features, including locations of inlets, swales, pipes, detention/retention facilities, BMPs, ponding areas, and all works.
17. Delineation and area of pre-development and post-development sub-basins.
18. Delineate retention/detention facilities and ingress/egress areas for facilities maintenance.

19. General type of soils by sub-basin and location of soil borings.
20. 10-, 25-, and 100-year flood elevations for any areas in or within 100 feet of the property. The source of these elevations shall also be shown on the plans.
21. Description of current ground cover, land use, and an estimate of the impervious area and percent imperviousness created by the construction activity by sub-basin.
22. Delineate the stream corridor protection zone along any streams within or adjacent to the site.

3. *Calculations*. Stormwater calculations (hard copy and original copy), signed and sealed by a professional engineer (registered in the State of Ohio) that the plan has been prepared in accordance with the regulations of the ordinance, and in accordance with good engineering practices and principles for all stormwater works, including design high water elevations for all applicable storm events. Software/models that utilize this methodology and technique and which are deemed acceptable to the City include but are not limited to SWMM, TR-55, PONDPAK, HEC-1, etc. The City will not accept methodologies that do not perform dynamic routing of hydrographs, which include but are not limited to the Bowstring Methodology, Mass Diagram Analysis, etc. The calculations shall include the following:

    a. Pre- and post-development stormwater flows and stages for the site and retention/detention ponds for all design storm frequencies pertinent to the project based upon the requirements of the stormwater regulations, including, but not limited to, the following:

        1. Critical Storm Calculation: Show the calculation of the total volume of runoff from a 1-year, 24-hour storm, before and after development. Show the calculation of percent increase in runoff volume, and reference Table 53-01 to determine the critical storm.
        2. On-Site and Off-Site Area Allocation(s): Show the allocation of on-site and off-site area contributory to the facility for each Stormwater Master Plan sub-basin as follows:

Area Allocation Table Example			
Sub-Basin Identifier #	**On-Site Area (acre)**	**Off-Site Area (acre)**	**Total (acre)**
5560	5.4	0.0	5.4
5570	10.5	0.0	10.5
5580	2.4	12.2	14.6
Total (acre)	18.3	12.2	30.5

        3. Pre-development hydrograph, post-development runoff hydrograph to the stormwater pond, and the routed post-development hydrograph discharged from the stormwater pond.

4. Pre-development and post-development runoff volumes.
5. Stage-area-storage calculations for the stormwater pond.
6. Stage-discharge calculations for the outfall control structure, including tailwater assumptions.
7. Release rate calculation: Calculate the maximum release rate for each design storm using the critical storm criteria and referencing Appendix C of the Stormwater Master Plan and the Area Allocation table. Include a summary of the release rates as follows:

Stormwater Management Summary Table

	1 year	2 year	5 year	10 year	25 year	50 year	100 year
Predeveloped Q							
Postdeveloped Q							
Allowable Release							
Actual Release							
Pond Depth/Elev							

8. Show the calculation that is used to determine the maximum release rate for each storm.
9. Stormwater quality control BMP volumes and recovery calculations. Show calculations or model output that demonstrates the release of the extended detention volume over the time period specified in the Ordinance.

b. Soil storage or curve number calculations per sub-basin, including impervious calculations.
c. Time of concentration calculations per sub-basin.
d. 100-year floodplain compensating calculations, if applicable.
e. Storm sewer, culvert, open channel and BMP tabulations, including, but not limited to, the following:

1. Location and type of structures.
2. Length of facility and dimensions, including diameter, height, and/or width for pipes.
3. Cross-sections for-open channels.
4. Sub-basin areas tributary to each structure.
5. Runoff coefficients or curve numbers per sub-basin for both the pre-construction and post-construction site conditions.
6. Time of concentration to the inlet of each structure.

7. Each stormwater flow to and from the stormwater structure or junction point.
8. Hydraulic gradient for the applicable storm event, including losses through structures with friction and local loss coefficients.
9. Estimated receiving water elevation with sources of information, if available.
10. Velocities for all facilities and details for provisions to control erosion.

f. Construction plans including, but not limited to, the following:

1. Overall project plan of roads, lots, and retention or detention facilities.
2. Cross-section of retention/detention facilities and BMPs.
3. Typical swale, ditch, or canal sections.
4. Drainage rights-of-way.
5. Road plan and profile with groundwater elevation shown in profile.
6. Overall project grading plan (at 1-foot contours) and individual lot grading plans.
7. Density of the project.

J. Erosion and Sediment Control

1. When required by this regulation, a soil erosion and sediment control plan shall be prepared for the earth disturbance activities. Furthermore, in accordance with the appropriate requirements of § 53.310, the plan shall be prepared, submitted to the City, and approved by the City, prior to any earth- disturbance.

2. The plan shall serve as a basis for all subsequent grading and stabilization and be incorporated as part of the final construction drawings.

3. *Plan Content*.

a. Any person seeking approval of an earth disturbance proposal shall, on a map rendered from a base derived from the site Stormwater Management Plan or site grading plan, at a scale not to exceed 1" – 100', provide the following information:

1. A description of the nature and type of the construction activity (e.g., low density residential, shopping mall, highway, etc.)
2. Total area of the site and the area of the site that is expected to be disturbed (i.e., grubbing, clearing, excavation, filling or grading, including off-site borrow areas).
3. Existing data describing the soil and, if available, the quality of any discharge from the site.

4. A description of prior land uses at the site.
5. An implementation schedule which describes the sequence of major construction operations (i.e., grubbing, excavating, grading, utilities and infrastructure installation) and the implementation of erosion, sediment and storm water management practices or facilities to be employed during each operation of the sequence.
6. The name and/or location of the immediate receiving stream or surface water(s) and the first subsequent named receiving water(s) and the aerial extent and description of wetlands or other special aquatic sites at or near the site which will be disturbed or which will receive discharges from disturbed areas of the project.

4. For subdivided developments where the Stormwater Management Plan does not call for a centralized sediment control capable of controlling multiple individual lots, a detail drawing of a typical individual lot showing standard individual lot erosion and sediment control practices. This does not remove the responsibility to designate specific erosion and sediment control practices in the Stormwater Management Plan for critical areas such as steep slopes, stream banks, drainage ways and stream corridor protection zones.

5. Location and description of any storm water discharges associated with dedicated, on-site asphalt and concrete plants covered by this permit and the best management practices to address pollutants in these storm water discharges.

6. A description of the intended maintenance plan with associated frequencies shall be required for the site.

7. Site map showing:

   a. Limits of earth-disturbing activity of the site including associated off-site borrow or spoil areas that are not addressed by a separate NOI and associated Stormwater Management Plan.

   b. Soils types should be depicted for all areas of the site, including locations of unstable or highly erodible soils.

   c. Existing and proposed contours.

   d. A delineation of drainage watersheds expected during and after major grading activities as well as the size of each drainage watershed, in acres.

   e. Surface water locations including springs, wetlands, streams, lakes, water wells, etc., on or within 200 feet of the site, including the boundaries of wetlands or stream channels and first subsequent named receiving water(s) the permittee intends to fill or relocate for which the permittee is seeking approval from the Army Corps of Engineers and/or Ohio EPA.

f. Existing and planned locations of buildings, roads, parking facilities and utilities.

g. The location of all erosion and sediment control practices, including the location of areas likely to require temporary stabilization during the course of site development.

h. Sediment and storm water management basins noting their sediment settling volume and contributing drainage area.

i. Permanent storm water management practices to be used to control pollutants in storm water after construction operations have been completed.

j. Areas designated for the storage or disposal of solid, sanitary and toxic wastes, including dumpster areas, areas designated for cement truck washout, vehicle fueling, and lay down areas.

k. The location of designated construction entrances where the vehicles will access the construction site.

l. The location of any in-stream activities including stream crossings.

8. Additionally, the plan, as part of the overall stormwater management plan, shall provide space for signatures of City of Dublin officials. These signature blocks shall be placed on the stormwater management plan drawings.

9. Statement identifying the name, address, and telephone number of the person(s) preparing the plan, the owner of the property where the grading is proposed and the developer and/or person responsible for the development area.

10. A statement indicating that the owner will notify the City forty-eight (48) hours before commencing any earth-disturbing activity. At the time this notice is given, the owner shall identify the site manager.

11. The City Engineer may waive specific requirements for plan detail or may require additional information to show that work will conform to basic requirements of this regulation.

12. *Calculations*

a. Any person seeking approval of an Erosion and Sediment Control Plan (ESC) shall submit design computations and applicable assumptions for all structural measures for erosion and sediment control. Volume and velocity of flow shall be provided for all surface water conveyance. This information shall also be provided for surface water outlets. Specific

guidance for Erosion and Sediment control calculations referenced in Section 320.

K. Standards & Criteria for Erosion & Sediment Control

(A) *Non-Structural Preservation Methods.* The ESC plan must make use of practices that preserve the existing natural condition as much as feasible. No construction shall be allowed within the Stream Corridor Protection Zone defined by these regulations unless explicitly allowed under Section § 53.210. In addition, construction operations shall be phased in order to minimize the amount of disturbed land at any one time. Within zones designated for active construction, tree preservation areas under §153.140 through §153.148 or other protective clearing or grubbing practices shall be designated.

(B) *Timing of Sediment-Control Practices.* Sediment control practices shall be functional throughout earth-disturbing activities. Sediment ponds (including sediment basins and traps) and perimeter controls intended to trap sediment shall be implemented as the first step of grading and within seven days from the start of grubbing. They shall continue to function until the upslope development area is re-stabilized.

(C) *Stabilization.* Disturbed areas must be stabilized as specified in the sections that follow.

(1) *Permanent Stabilization*

PERMANENT STABILIZATION	
Area requiring permanent stabilization	**When to implement controls**
Any areas that will lie dormant for one year or more	Within seven days of the most recent disturbance
Any areas within 50 feet of a stream and at final grade	Within two days of reaching final grade
Any other areas at final grade	Within seven days of reaching final grade within that area

(2) *Temporary Stabilization*

TEMPORARY STABILIZATION	
Area requiring temporary stabilization	**When to implement controls**
Any disturbed areas within 50 feet of a stream and not at final grade	Within two days of the most recent disturbance if the area will remain idle for more than 21 days
For all construction activities, any disturbed areas that will be dormant for more than 21 days but less than one year, and not within 50 feet of a stream	Within seven days of the most recent disturbance within the area For residential subdivisions, disturbed areas must be stabilized at least seven days prior to transfer of permit coverage for the individual lot(s).
Disturbed areas that will be idle over winter	Prior to the onset of winter weather

(3) Where vegetative stabilization techniques may cause structural instability or are otherwise unobtainable, alternative stabilization techniques must be employed.

(D) *Construction Access Routes.* Measures shall be taken to prevent soil transport onto surfaces or onto public roads where runoff is not checked by sediment controls. Off-site tracking of sediments and dust generator shall be minimized, as required under the City's Ordinance, §97.38.

(E) *Sloughing and Dumping.*

(1) No soil, rock, debris, or any other material shall be dumped or placed into a stream or into such proximity that it may readily slough, slip, or erode into a stream, unless such dumping or placing is authorized by the City Engineer and when applicable, the U.S. Army Corps of Engineers, for such purposes as, but not limited to, construction of bridges, culverts, and erosion control structures.

(2) Unstable soils that, in the opinion of the City Engineer, are prone to slipping or landsliding shall not be graded, excavated, filled or have loads imposed upon them unless the work is done in accordance with a qualified professional engineer's recommendations to correct, eliminate, or adequately address the problems.

(F) *Cut and Fill Slopes.* Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Consideration shall be given to the length and steepness of the slope, soil type, upslope drainage area, groundwater conditions, and slope stabilization.

(G) *Stabilization of Outfalls and Channels.* Outfalls and constructed or modified channels shall be designed and constructed to withstand the expected velocity of flow from a post-development, five-year frequency storm without eroding.

(H) *Establishment of Permanent Vegetation.* Permanent vegetation shall not be considered established until ground cover is achieved which, in the opinion of the City Engineer, provides adequate cover with a density of at least 70% and is mature enough to control soil erosion satisfactorily and to survive adverse weather.

(I) *Sediment deposition.* Sediment deposition caused by accelerated stormwater runoff over a development site or by accelerated erosion due to the sloughing or sliding of surface soil that has been exposed by grading, dumping, stockpiling or any other excavation-related earth disturbances shall be retarded and confined to within the boundaries of the development site, during site development.

(J) Sediment Control Practices During Construction. The ESC plan shall include a description of structural practices that shall store runoff during construction, allowing sediments to settle and/or diverting flows away from exposed soils or otherwise limiting runoff from exposed areas. Structural practices shall be used to control erosion and trap sediment from a site remaining disturbed for more than 14 days. Such practices may include, among others: sediment settling ponds, silt fences, earth diversion dikes or channels which direct runoff to a sediment settling pond and storm drain inlet protection. All sediment control practices must be capable of ponding runoff in order to be considered functional. Earth diversion dikes or channels alone are not considered a sediment control practice unless those are used in conjunction with a sediment settling pond. The ESC plan must contain detailed drawings for all structural practices.

(K) *Timing.* Sediment control structures shall be functional throughout the course of earth-disturbing activity. Sediment basins and perimeter sediment barriers shall be implemented prior to grading and within seven days from the start of grubbing. They shall continue to function until the up slope development area is restabilized according to requirements in Section §53.320(C)(1) As construction progresses and the topography is altered, appropriate controls must be constructed or existing controls altered to address the changing drainage patterns.

(L) Sediment settling ponds

(1) Concentrated storm water runoff and runoff from drainage areas, which exceed the design capacity of silt fence or inlet protection, shall pass through a sediment settling pond. For common drainage locations that serve an area with 10 or more acres disturbed at one time, a temporary sediment settling pond must be provided until final stabilization of the site. The permittee may request approval from Ohio EPA to use alternative controls if it can demonstrate the alternative controls are equivalent in effectiveness to a sediment settling pond. It is recommended that smaller sediment basins and/or sediment traps be used for drainage locations serving less than 10 acres.

(2) The sediment settling pond shall be sized to provide at least 67 cubic yards of storage per acre of total contributing drainage area. When determining the total contributing drainage area, off-site areas and areas which remain undisturbed by construction activity must be included unless runoff from these areas is diverted

away from the sediment settling pond and is not co-mingled with sediment-laden runoff. The depth of the sediment settling pond must be less than or equal to five feet. The configuration between inlets and the outlet of the basin must provide at least two units of length for each one unit of width (> 2:1 length:width ratio). Sediment must be removed from the sediment settling pond when the design capacity has been reduced by 40 percent (This is typically reached when sediment occupies one-half of the basin depth). When designing sediment settling ponds, the permittee must consider public safety, especially as it relates to children, as a design factor. Alternative sediment controls must be used where site limitations would preclude a safe design. The use of a combination of sediment and erosion control measures in order to achieve maximum pollutant removal is encouraged.

(M)Silt Fence and Diversions

(1) Sheet flow runoff from denuded areas shall be intercepted by silt fence or diversions to protect adjacent properties, streams, and stream corridor protective zones from sediment transported via sheet flow. Where intended to provide sediment control, silt fence shall be placed on a level contour. The use of other sediment barriers designed to control sheet flow runoff shall be at the discretion of the City Engineer. The relationship between the maximum drainage areas to silt fence for a particular slope range is shown in the following table.

SILT FENCE CRITERIA	
Maximum drainage area (in acres) to 100 linear feet of silt fence	**Range of slope for a particular drainage area (by percent)**
0.5	< 2%
0.25	> 2% but < 20%
0.125	> 20% but < 50%

(2) Stormwater diversion practices shall be used to keep runoff away from disturbed areas and steep slopes where practicable. Such devices, which include swales, dikes or berms, may receive storm water runoff from areas up to 10 acres.

(N) *Inlet Protection* Inlet protection BMPs shall minimize sediment laden water entering active storm drain systems, unless the storm drain system drains to a sediment settling pond. Sediment shall be removed from the storm sewer, to the extent possible, prior to final approval.

(O) *Other controls.*

(1) Non-Sediment Pollutant Controls

(a) No solid (other than sediment) or liquid waste, including building materials, shall be discharged in storm water runoff. The permittee must implement all necessary BMPs to prevent the discharge of non-sediment pollutants to the stormwater management system of the site or surface waters of the state. Under no circumstance shall concrete trucks wash out

directly into an open channel, storm sewer or surface waters of the state. No exposure of storm water to waste materials is recommended.

(P) *Compliance with other requirements:* The Stormwater Management Plan shall be consistent with applicable State and/or local waste disposal, sanitary sewer or septic system regulations, including provisions prohibiting waste disposal by open burning and shall provide for the proper disposal of contaminated soils to the extent these are located within the permitted area.

(Q) *Trench and ground water control:* There shall be no turbid discharges resulting from dewatering activities. If trench or ground water contains sediment, it must pass through a sediment settling pond or other equally effective sediment control device, prior to being discharged from the construction site. Alternatively, sediment may be removed by settling in place or by dewatering into a sump pit, filter bag or comparable practice. Ground water dewatering which does not contain sediment or other pollutants is not required to be treated prior to discharge. However, care must be taken when discharging ground water to ensure that it does not become pollutant-laden by traversing over disturbed soils or other pollutant sources.

(R) *Disposition of Temporary Practices*. All temporary erosion and sediment control practices shall be disposed of within thirty days after final site stabilization is achieved or after the temporary practices are no longer needed, unless otherwise authorized by the City Engineer. Trapped sediment shall be removed or permanently stabilized to prevent further erosion.

(S) *Maintenance.* All temporary and permanent erosion and sediment control practices shall be designed and constructed to minimize maintenance requirements. They shall be maintained and repaired as needed to assure continued performance of their intended function. The person or entity responsible for continued maintenance of permanent and temporary erosion controls shall be identified on the Stormwater Management Plan to the satisfaction of the City.